Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Headsight, Inc. Request for Waiver of	)	ET Docket No. 16-44
Part 15 of the Commission's Rules	)	
Applicable to Ultra-Wide Band Devices	)	

ORDER

Adopted: March 1, 2017 **Released: March 1, 2017**

By the Chief, Office of Engineering and Technology:

I. INTRODUCTION

1. By this Order, we grant a waiver of Sections 15.509(b) and 15.503(f) of our rules to Headsight, Inc. (Headsight) to permit the certification and marketing of an unlicensed ultra-wide band (UWB) ground penetrating radar (GPR) that will operate with its UWB bandwidth contained in the 1-6 GHz frequency band while installed on agricultural equipment.[1] Our action here will permit the use of GPR technology in a variety of agricultural applications, such as mapping soil conditions and harvesting crops precisely and efficiently.[2] We find that granting this waiver is in the public interest because this device poses no greater risk of causing harmful interference to authorized users of this spectrum than those devices already permitted under the existing rules, while providing for innovative uses of GPR technology that will benefit the public through improved farming operations and higher crop yields.

II. BACKGROUND

2. Part 15 of the Commission's rules permits low-power radio frequency devices to operate without an individual license from the Commission.[3] The technical and operating requirements are designed to ensure that unlicensed devices are unlikely to cause harmful interference to authorized radio services. Part 15, Subpart F, permits the operation of unlicensed transmitters using UWB technology employing very narrow or short duration pulses that result in very large (wideband) transmission bandwidths.[4] GPR devices are UWB imaging radars designed to obtain the images of buried objects or to determine physical properties within the ground.[5] Within Section 15.509, which permits unlicensed GPR and wall-imaging UWB devices to operate below 10.6 GHz, the preamble to subsection (b) limits their

[1] 47 C.F.R. §§ 15.503(f) and 15.509(b).

[2] *See Headsight Petition for Waiver of Part 15 of the Commission's Rules Applicable to Ultra-Wideband Devices*, filed Jan 21, 2016, ET Docket No. 16-44 (Headsight Request).

[3] 47 C.F.R. §§ 15.1 *et seq*.

[4] 47 C.F.R. §§ 15.501-15.525.

[5] Common applications include inspections of highways, bridges and runways, and determining the location of gas pipelines. Other applications include uses in forensic and archaeological studies. *See Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, Order, ET Docket No. 98-153, 17 FCC Rcd 13522, para. 3 (2002).

use to applications associated with law enforcement, firefighting, emergency rescue, scientific research, commercial mining, or construction.[6] Additionally, subsection (b)(1) limits the operation of these devices to "parties eligible for licensing under the provisions of part 90" (e.g., non-consumer entities engaged in specific commercial activities);[7] and subsection (b)(2) requires that the operation of GPR devices be coordinated with federal users via the Commission and the National Telecommunications and Information Administration (NTIA), as specified in Section 15.525 of the rules.[8] Section 15.503(f) requires GPR devices to operate only when in contact with, or within one meter of, the ground.[9]

3. Headsight filed a request seeking waiver of Sections 15.509(b) and 15.503(f) of the rules to use the UWB GPR wireless technology for agricultural applications. Headsight states that its device, the Terrahawk, uses UWB imaging technology between 1 GHz and 6 GHz to detect the ground surface conditions obscured by crops during harvest operations. This information allows for the precise positioning of the combine harvester's[10] cutting head (i.e., header height), which leads to faster harvesting operations, reduced operator fatigue, less machine wear and tear, and increased crop yields.[11] Headsight also anticipates use of the Terrahawk in the absence of crop cover to map sub-surface ground conditions such as moisture content and soil compaction.

4. Headsight describes that the Terrahawk is a sealed circuit board assembly containing a UWB GPR designed by Novelda AS. The assembly contains two modified bowtie antennae with a boresight gain of 4-6 dBi. Multiple Terrahawk devices can be mounted along the harvester's header along with a base controller to communicate via Wi-Fi to a small transceiver located in the operator's cab and connected to the harvester's touch screen display. Headsight indicates that two of the major limitations with the current standard use of mechanical arms that drag along the ground to measure header height are sensor failure and crop debris, which the Terrahawk can overcome by using GPR technology. Headsight explains that the Terrahawk can overcome these limitations because its radar signals can penetrate the fallen crop, measure the distance to the soil beneath, and provide protection to the header while allowing it to pick up much of the crop that would otherwise be lost.[12] However, because Part 15 does not currently allow the use of GPR for agricultural purposes, Headsight seeks a waiver of the restriction on permissible uses for GPR devices in Section 15.509(b).

5. Additionally, Headsight also seeks a waiver of the one-meter-above ground limitation of

[6] 47 CFR § 15.509(b).

[7] *See* 47 C.F.R. § 90.7 (defining "special industrial licensee" as "persons regularly engaged in any of the following activities: (1) the operation of farms, ranches, or similar land areas, for the quantity production of crops or plants; vines or trees (excluding forestry operations); or for the keeping, grazing or feeding of livestock for animal products, animal increase, or value enhancement; (2) plowing, soil conditioning, seeding, fertilizing, or harvesting for agricultural activities").

[8] 47 C.F.R. § 15.525. This section requires that the users of UWB imaging systems coordinate their intended operation with federal users through the Commission before the equipment may be used. Operators of this equipment are to provide to the Office of Engineering and Technology their name, address and personal contact information; the desired geographical area of operation; and the FCC ID number of the device. Manufacturers or authorized sales agents are to notify purchasers of this requirement. These coordination requirement for imaging devices were adopted to protect potentially affected federal government users that provide safety-of-life services.

[9] 47 CFR § 15.503(f) defines a GPR as "a field disturbance sensor that is designed to operate only when in contact with, or within one meter of, the ground for the purpose of detecting or obtaining the images of buried objects or determining the physical properties within the ground. The energy from the GPR is intentionally directed down into the ground for this purpose."

[10] The combine harvester is a machine that harvests grain crops. The name derives from its combining three separate operations comprising harvesting—reaping, threshing, and winnowing—into a single process.

[11] Headsight Request at 3.

[12] *Id.* at 6-7.

Section 15.503(f). Headsight explains that the Terrahawk will need to operate above the top of the crop height during certain situations, such as harvesting milo, when using farm equipment with "platform headers."[13] Such use would never be more than 10-12 feet (3-3.7 meters) above the soil surface, and would never extend more than one meter above the height of the crop canopy.[14] However, Headsight notes that the Terrahawk will operate within one meter of the soil surface in most conditions of use, and that it will always operate within a one-meter range in the absence of crop cover. Moreover, Headsight affirms that the Terrahawk's transmit antennas will always be pointed downward (i.e. toward the ground) in all use scenarios.[15]

6. The Office of Engineering and Technology (OET) issued a Public Notice seeking comment on the Headsight Request.[16] One party, Trimble Navigation Limited (Trimble) filed comments, and Headsight filed reply comments, as elaborated in more details below.

III. DISCUSSION

7. We are authorized to grant a waiver under Section 1.3 of the Commission's rules if the petitioner demonstrates good cause for such action.[17] Good cause, in turn, may be found and a waiver granted "where particular facts would make strict compliance inconsistent with the public interest."[18] To satisfy this public interest requirement, the waiver cannot undermine the purposes of the rule, and there must be a stronger public interest benefit in granting the waiver than in applying the rule.[19]

8. The UWB technical and operational standards in Part 15 were adopted to ensure that UWB devices, including ground penetrating radars, do not cause harmful interference to authorized radio services, including Federal services.[20] As we discuss below, a limited waiver of the restriction on permissible uses in Rule Section 15.509(b), and of the one-meter-above-ground limitation (not to exceed a height of 3.7 meter above the soil surface) in Rule Section 15.503(f) for Headsight's Terrahawk GPR device would not increase the potential for harmful interference to authorized services, i.e., the Terrahawk

[13] Headsight explains that "there are three types of combine headers for which the Terrahawk would be most applicable: corn heads, platform heads, and stripper heads. Corn heads are used specifically for harvesting corn. Platform heads can harvest a large variety of grains such as wheat, lentils, soybeans, rice, barley, flax, milo, peas, oats and mustard. Stripper heads can be used for many of the same standing grains as a platform heads, but are used in situations where it is desirable to leave the stalk standing and strip the grain from it." Headsight Request at 7. *See also* Letter from Terry Mahn, Counsel for Headsight Inc. to Marlene H. Dortch, Secretary, FCC, ET Docket 16-44 at 2 (filed April 26, 2016) (Headsight *Ex Parte*).

[14] Headsight *Ex Parte* at 2.

[15] Headsight Request at 4-5.

[16] *See Office of Engineering and Technology Declares the Headsight, Inc. Request For Waiver Of Certain Part 15 Ultra-Wideband (UWB) Rules to be a "Permit-but-Disclose" Proceeding for Ex Parte Purposes and Requests Comment*, DA 16-172, Public Notice, 31 FCC Rcd 1170 (2016).

[17] 47 C.F.R. § 1.3; *see also ICO Global Communications (Holdings) Limited v. FCC*, 428 F.3d 264 (D.C. Cir. 2005); *Northeast Cellular Telephone Co. v. FCC*, 897 F.2d 1164 (D.C. Cir. 1990); *WAIT Radio v. FCC*, 418 F.2d 1153 (D.C. Cir. 1969).

[18] *Northeast Cellular, supra* at 1166; *see also ICO Global Communications, supra* at 269 (quoting *Northeast Cellular*); *WAIT Radio, supra* at 1157-59.

[19] *See, e.g., WAIT Radio*, 418 F.2d at 1157 (stating that even though the overall objectives of a general rule have been adjudged to be in the public interest, it is possible that application of the rule to a specific case may not serve the public interest if an applicant's proposal does not undermine the public interest policy served by the rule); *Northeast Cellular*, 897 F.2d at 1166 (stating that in granting a waiver, an agency must explain why deviation from the general rule better serves the public interest than would strict adherence to the rule).

[20] *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, First Report and Order, ET Docket No. 98-153, 17 FCC Rcd 7435 (2002) (*UWB First R&O*); *see also*, 47 C.F.R. §§ 15.501-15.525.

poses no greater risk of causing harmful interference to radio communications services than any other GPR device operating under our rules. Hence, granting this waiver will not undermine the purpose of the rules. In addition, we find that there is a stronger public interest benefit in granting this waiver than in strictly applying the rules. The Terrahawk technology's ability to assist in harvesting crops precisely and efficiently by controlling the header height on harvesting machinery promises to bring increased crop yield and improved harvesting efficiency, which will benefit the American public.[21]

A. Waiver of Section 15.509(b) of the Commission Rules

9. We first address the waiver of the restriction on permissible uses in Rule Section 15.509(b) for Headsight so that it is eligible to certify the Terrahawk for operation in the proposed agricultural applications. Section 15.509(b) includes three separate provisions applicable to UWB GPR devices.[22] The first provision, identified in the preamble of this rule subpart, limits the use of GPR devices to applications associated with law enforcement, firefighting, emergency rescue, scientific research, commercial mining, or construction. The purpose of this provision is to ensure that GPR devices are used infrequently with a low proliferation rate, in order to avoid causing harmful interference to authorized users.[23] The second provision, identified in Section 15.509(b)(1), limits the operation of these devices to "parties eligible for licensing under the provisions of part 90,"[24] (in effect, to non-consumers entities engaged in certain commercial activities) to restrict proliferation of GPR devices in the consumer market. The third provision, identified in Section 15.509(b)(2), requires that the operation of GPR devices be coordinated with federal users via the Commission and the National Telecommunications and Information Administration (NTIA), as specified in Section 15.525 of the rules.[25] Headsight is only requesting waiver of the first provision, i.e., the restriction on permissible uses of UWB GPR devices.[26]

10. In its waiver request, Headsight argues that Section 15.509(b) does not expressly authorize UWB ground imaging devices for agricultural use only because agricultural use was never raised or discussed during the UWB rulemaking; it contends that the use of ground imaging technology in agriculture would have met the Commission's essential criteria of "low proliferation and infrequent use" because the Terrahawk would be used on agricultural equipment operating seasonally in rural areas.[27] Headsight also emphasizes that its waiver request does not propose any relaxation in the UWB emission limits or technical standards that apply to UWB GPR devices.[28]

11. In comments, Trimble, a provider of global positioning system (GPS) solutions, argues that Headsight has not provided the type of technical information necessary to demonstrate that there will be no interference to GPS operations. It names a variety of GPS applications that it believes the Terrahawk could interfere with, including the use of GPS receivers on farming machinery, on an aircraft

[21] Moreover, use of the UWB GPR technology will allow farmers to map sub-surface ground conditions such as moisture content and soil compaction, and can help them avoid hard-to-detect surface conditions such as uneven terrain and field stones that could present safety concerns for both workers and equipment.

[22] 47 C.F.R. § 15.509(b), (b)(1) and (b)(2).

[23] *UWB First R&O*, 17 FCC Rcd 7435, 7499 para. 185 (2002). Agricultural interests did not request to be included in the original list of permissible uses during the rulemaking.

[24] *See* definition of "special industrial licensee*"* in 47 C.F.R. § 90.7; *see also supra* note 7. This definition encompasses the potential users/operators of the Terrahawk, *e.g.*, farmers, farmer co-operatives, agricultural conglomerates, industrial/agricultural equipment providers, etc.

[25] 47 C.F.R. § 15.525; *see also supra* note 8.

[26] Headsight Request at 17.

[27] Headsight Reply at 4.

[28] *Id.* at 3.

landing on a runway adjacent to a farm field, and on a fire truck on a highway that runs alongside a farm field.[29] Trimble also questions why the Terrahawk could not operate in other spectrum, such as in the 76-81 GHz band.[30]

12. In reply, Headsight responds that it has performed compatibility testing between the Terrahawk and a GPS receiver mounted on the same farming machinery, and the test results showed no harmful interference.[31] With respect to Trimble's suggestion for operation in the 76-81 GHz band, Headsight states that radar signals at these frequencies will not effectively penetrate crops and other ground debris; therefore, the signal would not provide the kind of resolution and precision needed to determine the characteristics of the crop or the soil being investigated.[32]

13. *Discussion*. We find that Headsight's proposed use of the Terrahawk – seasonally, on farm equipment on agricultural land in rural settings and for limited periods of time[33] – is consistent with the criteria of "low proliferation and infrequent use" for GPR, because this specific use of GPR in agricultural applications does not differ greatly from any other permissible use listed in Section 15.509(b), such as that in construction applications.[34] Moreover, apart from allowing agricultural use — which is not on the list of permissible operations in Section 15.509(b) — we are not waiving the operating conditions of Sections 15.509(b)(1) and 15.509(b)(2). Users of the Terrahawk must be eligible for a license under Part 90 of our rules (which we expect they will be under the definition of "special industrial license"[35]). Furthermore, we will continue to require coordination of this device with Federal spectrum users as we would with any imaging system under the rules.[36]

14. We also determine that our UWB rules in general, and our very restrictive emission limits in the GPS frequency bands in particular,[37] are sufficient to protect other authorized services in this spectrum, as we decided to be extremely conservative when we adopted the UWB rules in 2002.[38] We find that our rules amply protect GPS receivers, whether co-located with the Terrahawk on the same farming equipment, or more distantly positioned, such as those mentioned in Trimble's comments, (e.g., in fire trucks traveling alongside a farm field, or in airplanes on nearby landing strips), as attested by the absence of harmful interference complaints resulting from the operation of UWB radars over the years. Additionally, Headsight is not requesting a relaxation of the emission limits for the Terrahawk. Compliance with our emission limits gives us assurance that GPS devices will receive the same protection from the Terrahawk as that which is currently provided by other UWB GPR devices on the permissible operators' list. We also observe that although Headsight's limited demonstration of compatibility

[29] Trimble Comments at 3.

[30] *Id.* at 4.

[31] Headsight Reply at 4-5.

[32] *Id.* at 8.

[33] *Id.* at 4.

[34] *UWB First R&O*, 17 FCC Rcd 7435, 7499 para. 185.

[35] *See* 47 C.F.R. § 90.7, *supra* note 7.

[36] We also note that Headsight is not requesting waiver of these two additional rule sections, as it confirms that the Terrahawk "will only be used for commercial activities" leading to "coordinated and controlled applications." Headsight Request at 17.

[37] 47 C.F.R. § 15.509(d).

[38] *UWB First R&O*, 17 FCC Rcd 7435, 7437 para. 1 (stating that "we are concerned, however, that the standards we are adopting may be overprotective and could unnecessarily constrain the development of UWB technology").

between the Terrahawk and a GPS device is neither comprehensive nor conclusive, the results, which are unchallenged by Trimble, do nevertheless support the sufficiency of our UWB limits.[39]

15. As a practical matter, we observe that harvesters and other pieces of farm equipment are commonly equipped with GPS receivers for precise crop management operations,[40] so the Terrahawk would be of little utility if it caused interference to a harvester's on-board GPS receiver. We would not expect farmers, who will have control over use of both devices, to use them together if they do not function together. Furthermore, we find that the continued application of the restrictions in Sections 5.509(b)(1) and (b)(2) on the operators of the Terrahawk (i.e., to ensure that they are industrial/business entities and that the operations are coordinated with federal users) will serve to avoid proliferation of this device into the consumer market. For all these reasons, we find that operation of the Terrahawk will be consistent with the use characteristics associated with UWB GPR applications and that it will not increase the potential for harmful interference to authorized users. Accordingly, grant of a waiver will not undermine the purpose of the rule.

16. Also, there is a stronger public interest benefit in granting this waiver than in strictly applying the rule. We find that a limited waiver of our UWB rules is warranted here because the Terrahawk cannot perform its functions at other frequencies, such as in the 76-81 GHz band, since radar signals at these frequencies would not provide the resolution and precision needed to accurately perform its intended work. Additionally, by allowing the Terrahawk's agricultural use, we will enable farmers to take advantage of state-of-the-art technology to analyze and appropriately exploit the soil to produce food more efficiently, avoid unnecessary crop loss, and improve harvest yield – thus benefiting the industry and consumers. For these reasons, we find that good cause exists for granting Headsight a waiver of the restriction on permissible uses in Section 15.509(b) so that it could certify the Terrahawk with the conditions described below.

B. Waiver of Section 15.503(f) of the Commission Rules

17. We now address the request for waiver of Rule Section 15.503(f) so that the Terrahawk can operate at crop height levels greater than one meter above the soil surface. The purpose of this rule is to ensure that GPR devices operate in a downward position, near the ground, in order for emissions to be attenuated and absorbed by the material against which they are placed, or by surrounding objects.[41]

18. In its waiver petition, Headsight requests that the one-meter "above ground" operating limit be applied in its case to mean one-meter operation above crop height.[42] Headsight states that different crops may have different heights and some crops, such as corn, are harvested close to the stalk near the soil level, whereas other crops, such as barley or milo or other grain cereal,[43] are harvested near the crop height.[44] Headsight requests that the Terrahawk be allowed to operate at a maximum height above the soil surface (i.e., without crops present) of no more than 10-12 feet (3.7 meters) but never more than one meter above the crop canopy.[45]

---

[39] Headsight Reply at 13 and Attach. 4.

[40] GPS-based applications in precision farming are being used for farm planning, field mapping, soil sampling, tractor guidance, crop scouting, variable rate applications, and yield mapping…[and allow] farmers to work during low visibility field conditions such as rain, dust, fog, and darkness. *See* http://www.gps.gov/applications/agriculture/; *see also*, Trimble Comments at 2.

[41] *UWB First R&O*, 17 FCC Rcd 7435, 7444 para. 20, 7454 para. 47, and 7499 para. 185.

[42] Headsight Request at 3.

[43] Milo or grain sorghum, is a cereal grass that does well in warm climates and grows upright to 2-4 feet (0.6 to 1.2 meters) in height.

[44] Headsight Request at 7.

[45] Headsight *Ex Parte* at 2.

19. Trimble contends that a UWB device operating several meters above the ground has the ability to produce harmful interference to GPS over a fairly wide area, even if it is pointing at the ground while transmitting. Trimble argues that Headsight did not provide data to support that crop material has the same ability to abate UWB radio frequency emissions as rocks, concrete or steel used in construction.[46] Trimble also questions whether "crops" could include plants and trees in urban areas.[47]

20. In reply, Headsight argues that the information regarding attenuation comparisons of crops to rock, concrete or steel is irrelevant as to whether the Terrahawk creates harmful interference to GPS devices, because Headsight has demonstrated by compatibility testing that this would not be the case.[48] Finally, Headsight affirms that there will be no harvesting in city gardens[49] or on trees[50] using farm machinery equipped with Terrahawk devices.

21. *Discussion*. We first note that, as Headsight indicates for many crops, the Terrahawk complies with the one-meter-above-ground limit; therefore, for all practical purposes, the waiver is only necessary in situations involving certain crops, such as milo, that are harvested near the crop height. This significantly further limits the percentage of time at which the device will need to operate under a waiver of Section 15.503(f).[51]

22. As we elaborated *supra*, our UWB emission limits are restrictive in general, and even more so in the GPS bands. We find that allowing the Terrahawk to operate one meter above the crop canopy, restricted to no more than 12 feet (3.7 meters) above the soil surface, will not increase harmful interference risks to GPS receivers (and any other receiver operating in the same band as the Terrahawk) for several reasons. First, the Terrahawk's emissions must be aimed in the direction of the ground to ensure effective harvesting operations. Hence, the device's downward positioned antenna[52] will ensure that its emissions are not pointed toward any nearby potential victim receiver unless this receiver is directly in its path and with its receive antenna aligned with the Terrahawk's antenna. Second, with the Terrahawk's antenna focusing on crops on the ground, emissions from the antenna's side lobes are unlikely to cause harmful interference under our restrictive UWB emission limits, even at the requested operating height – especially since any intervening object would lessen these emissions even further. Third, the Terrahawk will be attached to farm machinery operating inside fields during harvest operations, and the possibility of a potential victim receiver among crop plants is highly unlikely. Finally, the Terrahawk must typically operate with a co-located GPS receiver on-board the same farm equipment, and its usefulness would be obviated if it causes harmful interference to this co-located device. We can also expect similar protection to other radio services given that our limits on UWB emissions are designed to ensure that these emissions do not cause harmful interference.

23. However, to further restrict potential harmful interference by minimizing the amount of time that the Terrahawk will operate in non-compliance with our height-limitation rule, we will explicitly

[46] Trimble Comments at 4.

[47] *Id.* at 3.

[48] Headsight Reply at 7.

[49] *Id.* at 3.

[50] *Id.* at 6, fn. 13.

[51] For purposes of this analysis, we will not consider arguments that the top of crop canopy could itself be considered the "ground." *See id.* at 6. Under such an interpretation, a waiver of Section 15.503(f) would presumably no longer be necessary.

[52] A radar's main function is to measure or calculate the time delay between the transmitted signal and the return echo reflected off the surface of the material/object being measured to determine the material's or object's properties. To avoid false or inaccurate echoes, radar antennas are typically directional in order to better focus on the object being targeted. Headsight indicates that the Terrahawk's antenna's gain is 4 to 6 dBi, which would direct more of the energy into the ground. Headsight Request at 4.

require the device to operate no higher than 1 meter from the soil surface when the soil imaging is performed in free space (i.e., without crops beneath the device) e.g., for purposes such as mapping subsurface ground conditions for moisture content and soil compaction as described by Headsight, when this operation is not performed concurrently with harvest operations.[53] In other words, when used as a regular ground imaging radar in this manner (i.e., when crops are absent), the Terrahawk will be subject to the same height constraint as other UWB GPR devices operating under our rules. Accordingly, for all the above reasons, we find that granting this waiver will not increase the potential for harmful interference to authorized users, thus, it will not undermine the purpose of the rule. Moreover, we find that Headsight has met the threshold for a waiver of our rules, and that we need not reach the determination whether losses to the Terrahawk's emissions caused by crops are equivalent to those caused by other ground materials, such as rocks or concrete, as Trimble alludes to.[54]

24. To ensure that granting the waiver of Section 15.503(f) will not increase the potential for interference to authorized users, we will require that measurements showing compliance with the emission levels specified in Sections 15.509 (d) and (e) be performed with the Terrahawk positioned at heights of 1, 2, 3 and 3.7 meters above the ground. Furthermore, to avoid potential aggregation of emissions from multiple Terrahawk transmitters, we will require a minimum separation distance of 1.5 meters (~ 5 feet) between transmitters when they are installed for operation on a single piece of farming machinery (a combine harvester, ground tiller, fertilizer, etc.).

25. In addition, there is a stronger public interest benefit in granting this waiver than in strictly applying the rule. By allowing the Terrahawk to operate one meter above crop heights, it can be used in conjunction with the harvesting of many crops, including tall cereal crops.[55] Allowing farmers to obtain timely and accurate data on soil composition, and crop conditions will lead to higher crop yields, which in turn will benefit the American public. We thus find good cause exists for granting Headsight a waiver of Section 15.503(f). To further ensure that harmful interference to authorized operations will not occur, we impose explicit conditions on the testing and operation of the Terrahawk under this waiver, as follows:

WAIVER CONDITIONS

26. The following conditions shall apply to the waiver being granted to Headsight for the testing, certification and operation of the Terrahawk GPR device:

a) The Terrahawk shall be tested for compliance with all the technical specifications applicable to operation under 47 CFR Part 15.[56] However, compliance with the restriction on permissible uses of GPR devices in 47 CFR § 15.509(b), and with the one-meter-above-ground limitation of 47 CFR § 15.503(f) is waived to allow the device to be used for agricultural purposes, at a height of one meter above crop heights, but not to exceed 12 feet (3.7 meters) above the soil surface.

b) The measurements to show compliance with the emission levels specified in 47 CFR §§ 15.509(d) and (e) must be performed with the Terrahawk positioned at 1, 2, 3, and 3.7 meters above the ground. Compliance measurements shall be performed according to Commission-

[53] Headsight Request at 5.

[54] Trimble Comments at 4.

[55] While the waiver will allow for the use of the Terrahawk in many settings, we recognize that there are some situations where it will not be available. In addition to the use in city gardens or on trees (which we are explicitly excluding), activities such as the top-cutting of hops vines would typically exceed the absolute 12-foot height limit.

[56] *See* Knowledge Data Base (KDB) No. 393764, *Ultra-Wide Band Device Frequently Asked Questions*, available at https://apps.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?id=20253&switch=P.

approved test procedures to obtain worst-case emission levels.[57]

c) Multiple Terrahawk transmitters intended to be mounted on a single piece of farming machinery (a combine harvester, ground tiller, fertilizer, etc.) in any installation shall be positioned for operation with a minimum separation distance of 1.5 m (~ 5 feet) between transmitters. Testing shall be performed with two (2) Terrahawk transmitters mounted with this separation distance, while transmitting simultaneously, to demonstrate compliance with the emission limits specified in 47 CFR §§ 15.509(d) and (e), using Commission-approved test procedures.[58]

d) The Terrahawk shall comply with the coordination requirements in 47 CFR § 15.525. The manufacturer of the Terrahawk, or its authorized sales agents, must inform purchasers and users of this device about the requirement to undertake detailed coordination of operational areas with the FCC and NTIA prior to the equipment being operated.

e) The Terrahawk's emissions shall be aimed downward toward the ground so they can be attenuated by the presence of crops, and shall not be operated at a height of greater than 1 meter when there are no crops beneath the device.

f) The Terrahawk shall only be installed on farming machinery (combine harvesters, ground tillers, fertilizers, etc.) and operated in fields that are located in rural or predominantly agricultural areas as generally defined by the United States Geological Survey National Land Cover Database (NLCD) classifications 81 (Pasture/Hay) and 82 (Cultivated Crops).[59]

g) Operation of this device shall be limited to parties eligible for licensing under the provisions of part 90 of the Commission's rules (e.g., persons regularly involved in activities such as the operation of farms, ranches, or similar land areas, for the quantity production of crops or plants; including soil plowing, soil conditioning, seeding, fertilizing, or harvesting for agricultural activities). No operation in city gardens or on trees is permitted.

h) This waiver shall apply only to the Terrahawk GPR device as described herein, and is not to be considered to apply generally to other UWB GPR devices. A copy of this Order shall be provided with the application for certification of the device.

IV. ORDERING CLAUSE

27. Accordingly, pursuant to authority in Section 0.31, 0.241 and 1.3 of the Commission's rules, 47 CFR Sections 0.31, 0.241 and 1.3, and Sections 4(i), 302, 303(e), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154(i), 302, 303(e), and 303(r), IT IS ORDERED that the requests for waiver of the restriction on permissible uses of GPR devices in Section 15.509(b), and of the one-meter-above-ground limitation of Section 15.503(f), 47 C.F.R. §§ 15.509(b) and 15.503(f), for Headsight, Inc. ARE GRANTED, subject to the conditions listed above. This action is effective upon release of this Order.

---

[57] Compliance testing of UWB transmitters is found in Standard C63.10-2013, *American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices*, Clause 10, available at https://standards.ieee.org/findstds/standard/C63.10-2013.html.

[58] Test procedures for compliance testing of multiple Terrahawk transmitters (that are not found in Standard C63.10, *see supra* n.57) must be reviewed and approved by the Commission Laboratory staff.

[59] NLCD Classifications 81 and 82 cover all land areas classified as "Planted/Cultivated" in the United States. *See* https://www.mrlc.gov/nlcd11_leg.php.

28. IT IS FURTHER ORDERED that, if no petitions for reconsideration or applications for review are timely filed, this proceeding SHALL BE TERMINATED and the docket CLOSED.

FEDERAL COMMUNICATIONS COMMISSION

Julius P. Knapp
Chief, Office of Engineering and Technology